Semi-analytic approach for coupling issues in photonic crystal structures

P. Sanchis, P. Bienstman*, R. Baets*, and J. Marti
Nanophotonics Technology Center, Universidad Politécnica de Valencia, Camino de Vera s/n, 46022 Valencia, Spain
*Ghent University, Department of Information Technology, Interuniversity Micro-Electronics Centre (IMEC), Sint-Pietersnieuwstraat 41, B-9000 Gent, Belgium.

A semi-analytic approach based on previously derived closed-form expressions for the transmission and reflection matrices between a dielectric waveguide and a semi-infinite photonic crystal (PhC) waveguide [1,2] is proposed for analyzing coupling issues in PhC structures. The proposed approach is based on an eigenmode expansion technique and introduces several advantages with respect to other conventional numerical methods such as a shorter computation time and the possibility to calculate parameters, such as the reflection into PhC structures, difficult to obtain with others methods. Two different examples are analyzed and results compared to finite-difference time-domain (FDTD) simulations to prove the usefulness of the proposed approach: (i) an especially designed two-defect configuration placed within a PhC taper to improve the coupling efficiency and (ii) a coupled-cavity waveguide (CCW) coupled to a single-line defect PhC waveguide by using an adiabatic taper.

[1] P. Sanchis, P. Bienstman, B. Luyssaert, R. Baets, and J. Marti, “Analysis of butt-coupling in photonic crystals”, IEEE Journal of Quantum Electronics, vol. 40, pp. 550, 2004.
[2] P. Sanchis, J. Martí, B. Luyssaert, P. Dumon, P. Bienstman and R. Baets, “Analysis and design of efficient coupling in photonic crystal circuits”, to be published in Optical and Quantum Electronics.